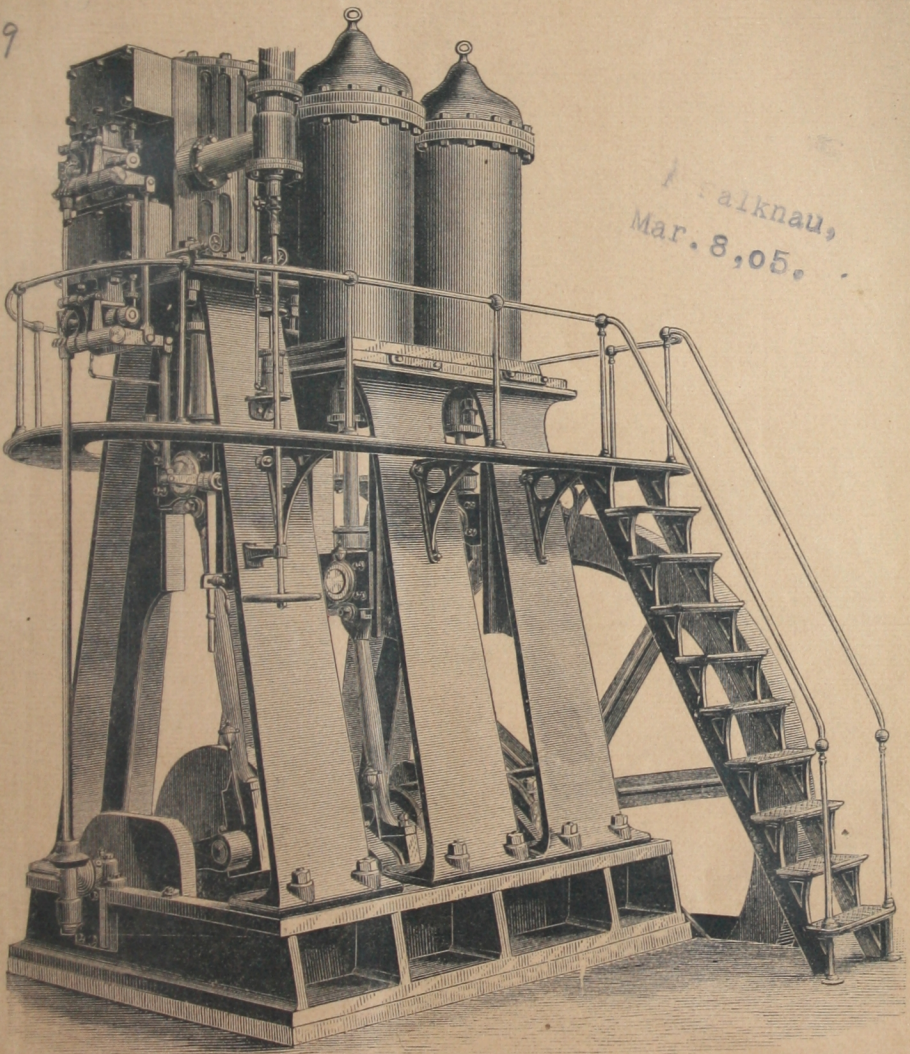
1884
9
Falknau,
Mar. 8,05.

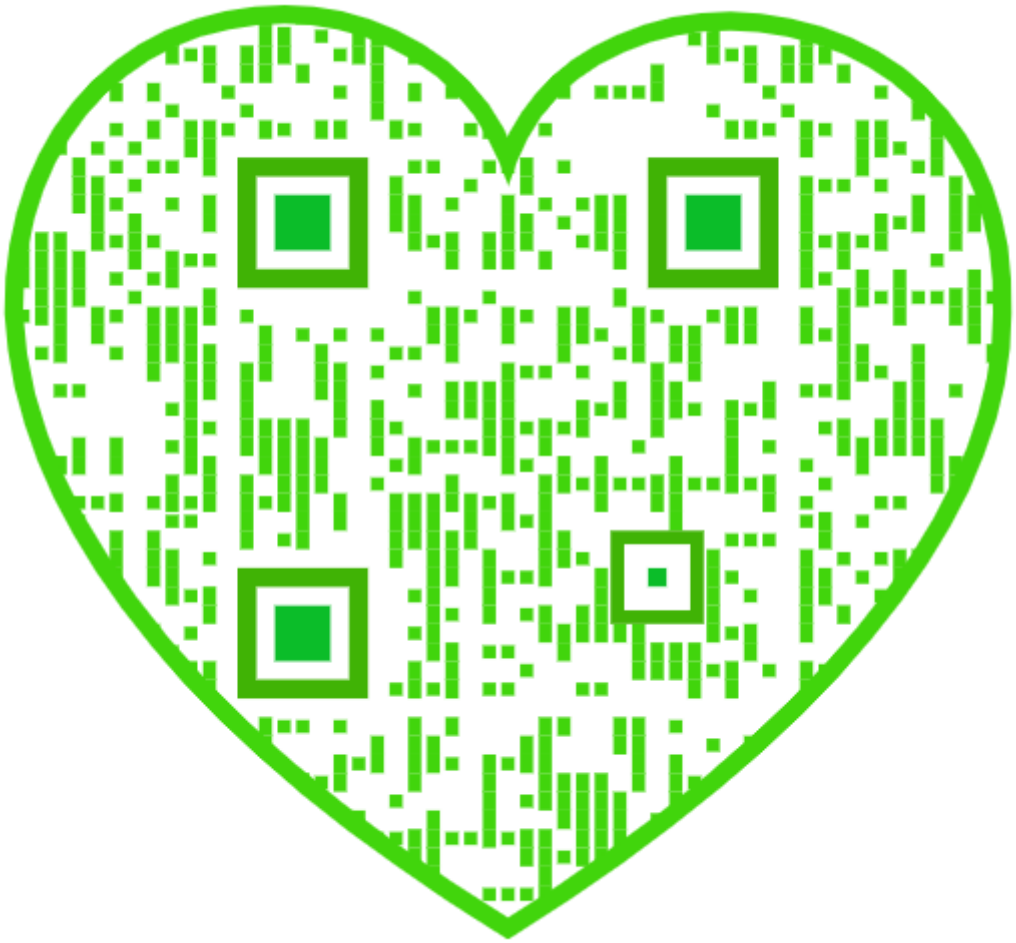


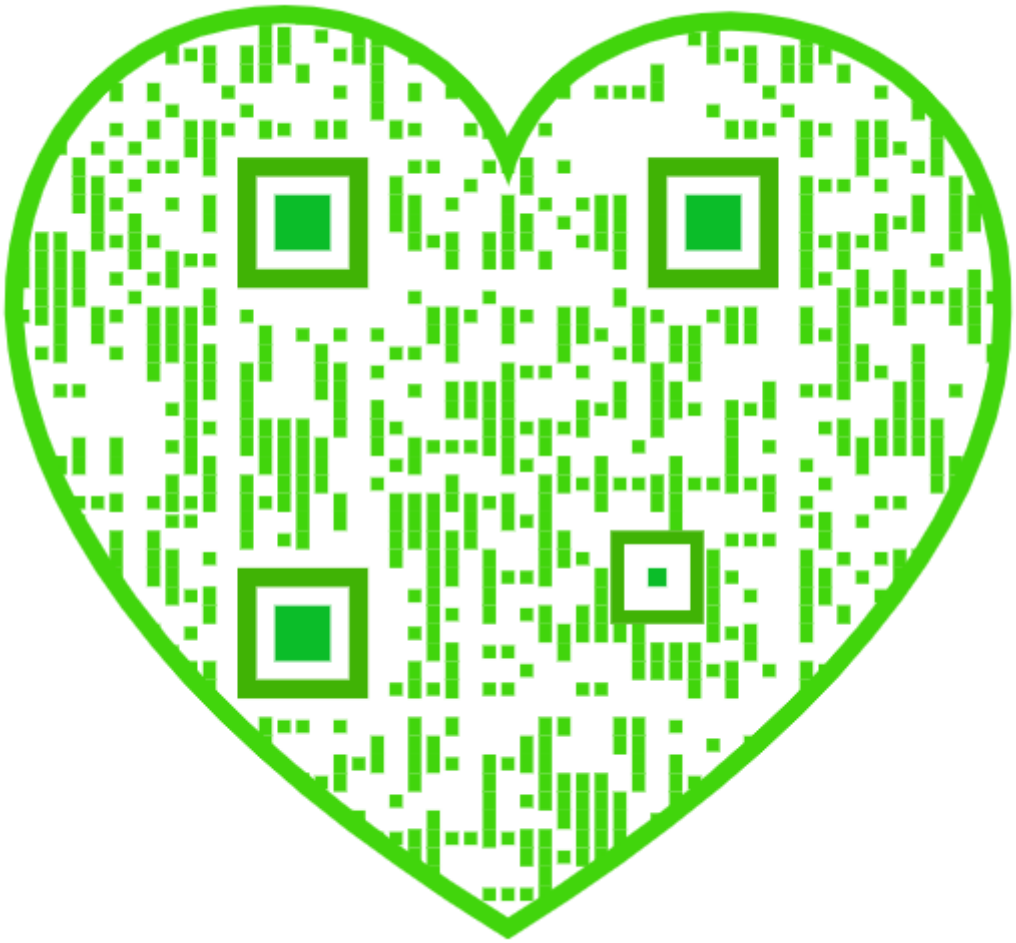
THE WOOD-BAILIE

ICE MACHINE AND REFRIGERATING COMPANY,

69 WALL STREET,

NEW YORK.





Class 621.5 Book W853 Accession 6081
From A. Falkenau, Mar. 8. '05
REFERENCE. PAMPHLET.

THE

Wood-Bailie Ice-Making

AND

Refrigerating Machine.

PATENTED.

USING ANHYDROUS LIQUID AMMONIA.

The only Ammonia Gas Machine that can be used successfully on Shipboard.

The production of Ice at sea on ships, in any climate, the refrigeration of cold-storage rooms and holds of vessels, and the cooling of water without the use of ice, is a special feature of this system.

THE WOOD-BAILIE ICE MACHINE AND REFRIGERATING COMPANY,

69 WALL STREET, NEW YORK.

THE WOOD-BAILIE ICE MACHINE AND REFRIGERATING COMPANY,

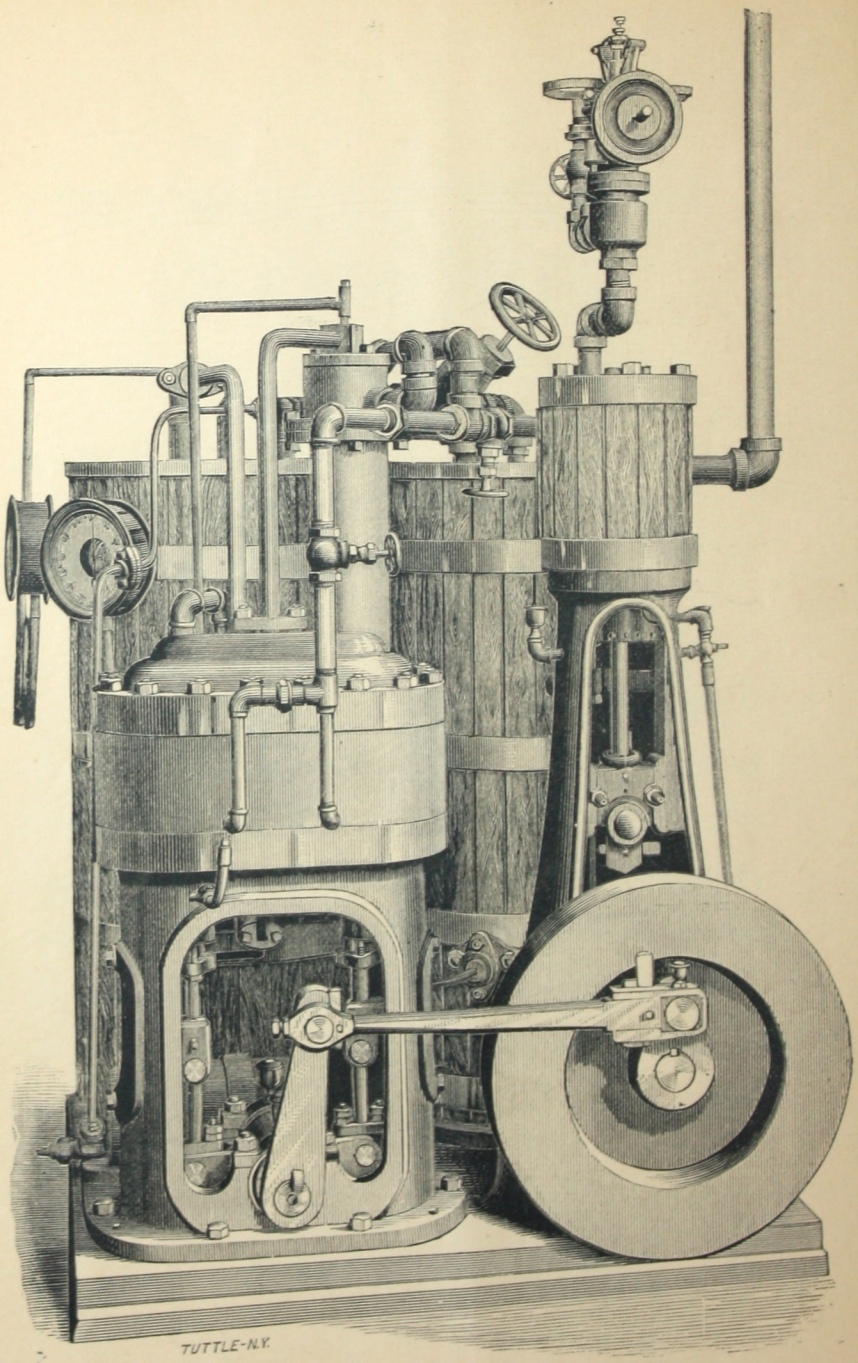
69 WALL STREET, NEW YORK.

GEO. SHEPARD PAGE, President.
JOS. R. WEST, Vice-President.
GEO. G. PORTER, Treasurer.
CHAS. E BOOTH, Secretary.
WILLIAM L. BAILIE, Engineer.
CHAS. F. SMITH, General Manager.

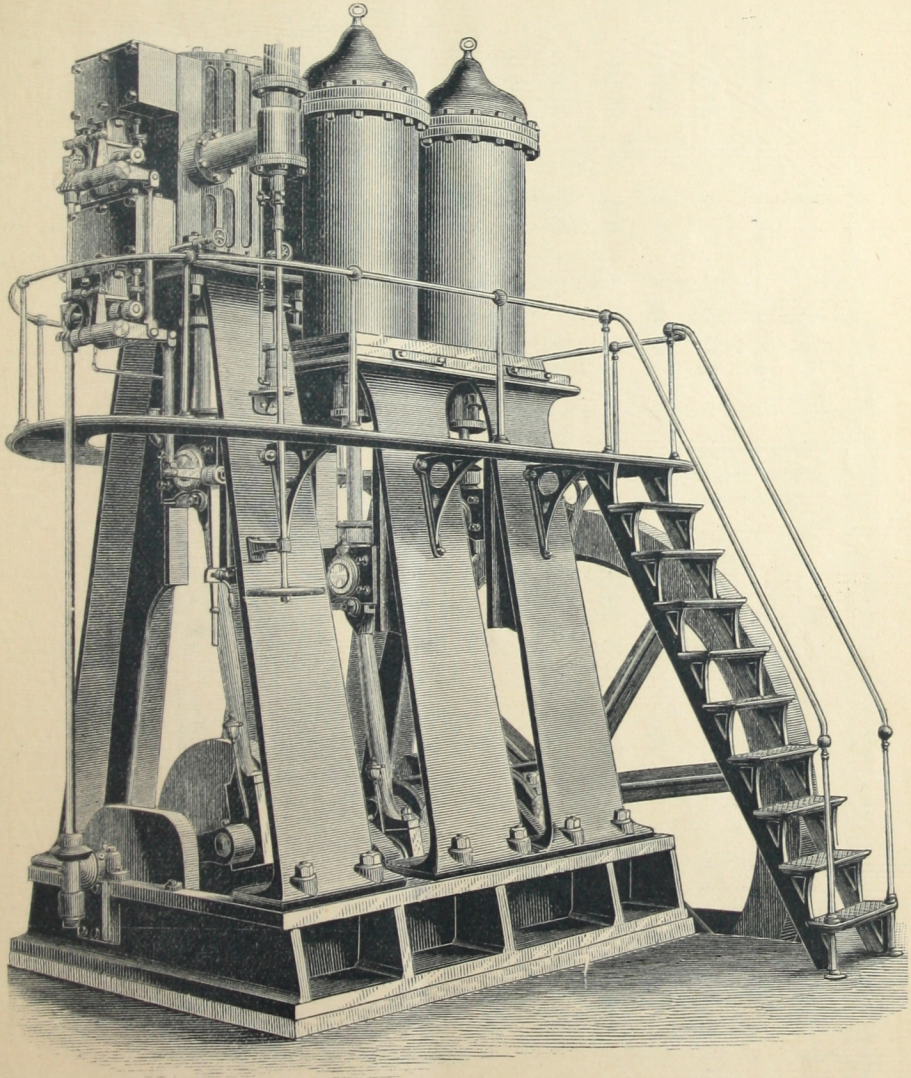
The business formerly conducted by Messrs. W. M. WOOD and W. L. BAILIE, under the name and style of WOOD & BAILIE at Washington, D. C., has been sold to, and assumed by, "THE WOOD-BAILIE ICE MACHINE AND REFRIGERATING COMPANY," with its general offices at 69 Wall Street, New York, where all correspondence should be addressed. Messrs. WOOD & BAILIE still retain their connection with the business, both occupying the position of Directors in the new Company, and the latter the position of Engineer.

THE WOOD-BAILIE ICE MACHINE AND REFRIGERATING COMPANY.

1809.



The Wood-Bailie Ice Making and Refrigerating Machine.
Elevation of small sizes.
Capacity: 500, 1000, 3500, and 5000 pounds of Ice per day.
Machine complete on a single bed-plate.



The Wood-Bailie Ice Making and Refrigerating Machine.
Elevation of the Engine and Compressors, ONLY, of the large sizes.
Capacity: 5, 10, 15, 25, 30, 35, and 40 tons of Ice per day.

Number of Machine.	Ice making Capacity in 24 hours. lbs.	Refrigerating Capacity in 24 hours. tons of ice.	Horse-power Required.	*Condensing Water Required per Minute. gallons.	Size of Bed-plate	Floor Space Required.	Height Over All.	Weight of Machine. lbs.
0	500	½	½	⅓	3′x3′ 6″		6′ 6″	2,000
1	1,000	1	1	⅔	4′x4′		6′ 6″	3,000
2	3,500	3½	3¼	1½	5′x5′		6′ 6″	4,000
3	5,000	5	4½	2	6′x6′ 6″		6′ 6″	6,000
4	10,000	10	9	4¾	*In the four small machines, the entire construction is placed on a single bed-plate.*	5′x5′ 6″	7′ 7″	7,500
5	20,000	20	18	9		8′x7′	9′ 7″	17,000
6	30,000	30	27	13¾		8′x7′	9′ 7″	17,000
7	50,000	50	45	24		11′x9′ 6″	12′ 3″	46,000
8	60,000	60	54	29		12′x9′ 7″	12′ 6″	54,900
9	70,000	70	63	34		12′x9′ 7″	12′ 6″	54,900
10	80,000	80	72	38		12′x9′ 7″	12′ 6″	54,900

* At a temperature of 56°, the pressure in the compressor will not exceed 125 pounds per square inch.

THE PRINCIPLE OF REFRIGERATING MACHINES.

Cold may be produced artificially in several ways, the most successful system of mechanical refrigeration proceeding on the general principal of compressing a gas until it reaches the point of liquefaction; the heat of compression (specific heat) and also of liquefaction (latent heat) is then removed from it by passing the liquid through a coil of pipe surrounded by running water; after this reduction of temperature the liquefied gas is permitted to expand in a series of coils or pipes placed in a tank containing brine, and as it resumes its original gaseous condition it absorbs the heat of the saline solution, including a large amount of heat not indicated by the thermometer, which is called latent heat.

The brine, thus reduced to a temperature of from 10° to 24° Fahr., is then forced through pipes arranged in a closed box, in which cans or moulds containing water are placed, if ice is to be produced, or suspended from the ceilings of rooms, if refrigeration be required.

This method of circulating a cooling liquid is known as the "brine circulation" system, and is the one we recommend.

The brine is simply a saturated solution of common salt, or chloride of calcium.

Another system, known as the "direct expansion," consists in allowing the gas to expand through the circulating pipes; the advantages of this system over the first one are very slight, being confined principally to the one merit of having no action on the pipes, as ammonia will not corrode iron, but, on the other hand, the cost of the ammonia required above that of brine, and the expense of extra heavy over common iron pipe, make the first cost of a "direct expansion" circulating plant double the cost of a similar brine plant. But, apart from financial considerations, the loss of life which would probably be occasioned by a leak in the "direct expansion" system, where a high pressure is carried, should of itself be a sufficient reason to preclude its adoption.

The Wood-Bailie machines are rated at their capacity for ice-making, which is only one-half their efficiency for cooling as compared with ice melted. That is, a five-ton Wood-Bailie machine will do as much work in reducing the temperature of a room as the melting of ten tons of ice. This should always be borne in mind, as some manufacturers rate their machines according to their capacity for refrigeration.

The smaller sizes of this machine are especially adapted to meet the demand for artificial refrigeration on vessels. Heretofore this has been but crudely accomplished by means of cumbersome air-machines, whose great weight and large size rendered their use almost impracticable where room is so valuable as on board ship. The requirements for this purpose—while the machinery is exposed to the most severe tests—are little space, and security from derangement. To meet this the apparatus must be self-contained, as shown in the cut. The entire refrigerating machinery, including the steam-engine, is placed upon one solid bed-plate, and all the parts are so firmly secured that any movement within itself is impossible. This condition is very necessary on ships, where the machinery must be secured from any internal working of the vessel, which is sure to occur in a heavy sea.

These characteristics of the Wood-Bailie machine render it valuable in all cases where reliable machinery is required.

Anhydrous ammonia is the refrigerating agent selected as possessing a greater value for the purpose than any other refrigerant known. It enables the use of a compressor of the smallest possible form, and lessens the size and weight of other parts of the apparatus in like proportion. The other advantages are that it is entirely free from any danger by contact with fire; it has no action whatever on the material used in the construction of the machinery, and is harmless when inhaled, unless in large quantities.

The pressure of the ammonia is not excessive, being no greater than the average pressure carried in the steam boilers of the present day. This pressure is dependent upon the temperature and quantity of the condensing water. In the hottest days of summer, using the water from the Potomac River, the pressure has not been over 150 pounds per square inch.

The gas compressor used with this apparatus was designed by Messrs. Wood and Bailie for the purpose, and has special features, the advantages of which are simplicity, freedom from derangement, economy of performance, compact form, and accessibility to all parts.

The coils are made of the best extra heavy iron pipe in one piece, and all pipes through which the ammonia passes are of the same material. All joints are securely and simply made and in plain sight, so that no leakage can occur without immediate detection.

The entire apparatus before it leaves the shop is tested under a hydrostatic pressure of 500 pounds per square inch, and again under an air pressure of 300 pounds per square inch, to test the perfection of castings and joints.

THE ADVANTAGES OF THE WOOD-BAILIE ICE AND REFRIGERATING MACHINE.

1. *Efficiency of the Gas Compressor.*

For economical working in compressing gas it is necessary to have a complete discharge of the contents of the cylinder, either by close-working parts or the use of oil.

In some of the first machines constructed on the former plan the clearance (space between the piston and the cylinder head) was only 1–64 of an inch, which required the closest attention from the engineer in order to prevent the loosening of the piston rod in the cross-head, and not an hour passed without careful examination of these parts.

In machines of more modern construction, the desired result is obtained, although in an imperfect manner, by pumping into the cylinder a large quantity of oil, which, on the upward stroke of the piston, fills the clearance space.

This system is also objectionable, for the circulation of the oil makes it a complicated one, and enough ammonia is absorbed by the oil to cause a great loss of power. These difficulties have all been completely overcome in the Wood-Bailie machine, by means of a simple and very effective valve motion, in which there is absolutely no clearance, and the full volume of ammonia gas in the cylinder is delivered at every stroke of the piston, thereby effecting a saving of from 20 to 50 per cent over every other machine, and enabling the mechanism to be made smaller, lighter, and consequently cheaper, for an equal amount of work.

---

2. *Simplicity of Construction.*

In our piston and main discharge valve there are only two movable parts, while the piston itself consists of only eight parts, including rings, piston valve, and nuts; this being the case, it does not need an expert machinist to comprehend and appreciate the simplicity of the Wood-Bailie mechanism over other systems, in some of which there are as many as 53 separate parts in the piston and discharge valve, including 20 movable parts in the former alone.

The joints, pipe-work, and stuffing-boxes of the Wood-Bailie machine are also of such a character that it is almost impossible for any leak or derangement to occur, and the working parts may be easily removed for repairs and replaced with very little loss of time or gas.

Any man who can run and care for a small steam-engine and boiler

can in a week be taught all that is necessary to run this machine; as it is furnished with the best governors, automatic oil cup, etc., the attention is reduced to a minimum, and the engineer can give almost his whole attention to the fires, and, in the small machines, to the removal of the ice.

---

3. *Interchangeable Parts.*

Every working part is made to a standard gauge, and may be duplicated at any time.

---

4. *Economy in Oil.*

The valves, packing-rings and working parts, generally, are all lubricated and oil-sealed, automatically, without the use of an excessive quantity of oil.

---

5. *Machine Self-contained.*

Only very small space is required, for the entire construction of the machine is so compact that the smaller sizes (500, 1000, 3500, and 5000 lbs.) are each placed on a single bed-plate; this reduces the chance of leakage to a minimum, and permits the use of the machine where economy of room is a desideratum, especially on shipboard, where the straining and working, which is unavoidable in the strongest vessels, soon cause leaky joints in machines whose parts are detached, and more or less separated.

The Fahrenheit thermometer is used in the United States, Holland, Great Britain, and her colonies.

The freezing point is placed at 32°, and the boiling point at 212°.

The Centigrade is in common use on the Continent of Europe, and is very generally employed in scientific investigations elsewhere. In Northern Europe it is known by the name of its inventor, Celsius, a Swedish astronomer. The freezing point is put at zero, and the boiling point at 100°.

A third scale, suggested by Réaumur, and still employed in Germany and Russia, divides the range from the freezing to the boiling point into eighty degrees.

To convert Fahrenheit into Centigrade subtract 32, and divide the remainder by 1.8.

To change Centigrade into Fahrenheit multiply by 1.8, and add 32.

To alter Fahrenheit to Réaumur subtract 32, and divide by 2.25; or, *vice versa*, multiply by 2.25 and add 32.

ADVANTAGES IN THE USE OF REFRIGERATING MACHINERY OVER NATURAL ICE.

1. The temperature of fermenting rooms and stock cellars in brewing establishments, and cold storage rooms generally, may be exactly regulated, which is impossible by the use of ice.

---

2. The temperature of cold storage rooms may be, if necessary, reduced much below the temperature attainable by using ice. Ice cannot be depended upon to reduce the temperature of the air below 32° Fahr., but all kinds of meat are kept in much better condition in rooms having a temperature as low as from 26° to 28° Fahr.

---

3. Mechanical refrigeration of breweries, cold storage rooms, etc., entirely avoids the waste, dirt, and cost of handling natural ice.

---

4. Cooling effected by refrigerating machines renders the air dry by condensing the moisture of the atmosphere on the circulating pipes; this is of considerable importance in breweries, and especially so where meat is stored, as moist air has a very injurious effect on it.

---

5. Mechanical refrigeration by use of cold brine circulating through iron pipes suspended from the ceiling, increases the capacity of fermenting rooms and stock cellars in breweries, and chill rooms generally, from 25 to 50 per cent over similar establishments where ice is used.

---

6. Artificial ice, being usually made from distilled water, is cleaner, clearer, and purer than natural ice.

Ice taken from lakes or ponds, and even from rivers where the current is sluggish, frequently contains foreign matter which may be readily seen, but organic animal impurities are difficult of detection, and are often very dangerous to health.

---

7. Artificial ice may be frozen in any desired shape or weight, is harder than the natural product, and will not melt so quickly.

---

8. Artificial ice, or refrigerating by machinery, costs less than natural ice. The expense depends largely on the cost of fuel and labor; where that is cheap, ice can be produced at a very low figure. One gross ton of coal will produce from 10 to 14 net tons of ice, the amount

made being governed by the kind of fuel consumed, the efficiency of the boiler used, the character of its setting, the care and intelligence of the engineer, and the scale on which the manufacture is conducted.

It is estimated by leading brewers in New York City and vicinity that the total cost of cooling one barrel of beer by the use of refrigerating machinery is as low as from 4½ to 6½ cents, while the cost, using natural ice at $2.50 per ton, is from 18 to 24 cents.

We make a specialty of small plants for hotels, theaters, private residences, hospitals, and ship use.

An ice box is only needed when the machine is used for the manufacture of ice. When refrigeration only is required, the box is dispensed with, and the cold brine is merely circulated through the cold storage rooms. If desired, as is frequently the case, the work of the machine may be divided, a portion to ice-making and the remainder to refrigeration.

A good supply of water is necessary, though it need not be fresh, except for making ice. If obtained from springs or artesian wells, it is an advantage, as the temperature is generally lower than river water.

A thermal or heat unit is the heat required to raise the temperature of one pound of water one degree Fahrenheit; water, at 60° Fahrenheit, contains 170 thermal units; the elimination of twenty-eight degrees of sensible or *specific* heat will reduce the temperature of the water to the freezing point, 32° Fahrenheit—but it is necessary to expel the remaining 142 degrees of *latent* heat before the water will change into ice at the same temperature; this explains the reason why it requires a much longer time, and the expenditure of six times the power to manufacture ice that it does to cool water from 60° Fahrenheit to the freezing point.

The mechanical equivalent of the unit of heat is 772 foot-pounds.

In all cases where steam is used it is economy to have plenty of power, as forcing a boiler is always attended with expensive results.

In order to obtain perfectly clear transparent ice, it is necessary to freeze the water slowly, and it is desirable to have it distilled or filtered.—When only a portion of the capacity of the machine is devoted to ice-making the exhaust steam will frequently furnish a sufficient quantity of distilled water.

COMPRESSION AND ABSORPTION MACHINES.

The systems of mechanical refrigeration are divided generally into the two classes of compression and absorption machines.

The compression machines are subdivided into two kinds, viz.:

First. Those using air or a gas, which does not change its state, being alternately compressed and expanded, but always remaining a gas. In these machines the efficiency depends upon the specific heat of air or the gas used, and they are therefore the least economical of all the machines constructed on the compression plan.

Second. Those using a volatile liquid, such as ether, chymogene, sulphurous oxide, ammonia, etc., which rapidly expands, when the atmospheric pressure is removed, changing at once from a liquid to a gas, and taking up an amount of heat from surrounding substances which depends on the capacity of the chemical used for absorbing latent heat. Of all volatile liquids anhydrous ammonia has the highest latent heat, and is therefore the most effective refrigerant known; for this reason it has been adopted in the Wood-Bailie machines.

In ammonia absorption machines the gas is distilled by direct application of heat to aqua ammonia, and as the gas is evolved it is accumulated in a receiver or reservoir until its pressure is great enough to liquefy it.

It is now supposed to be at the same point at which the compression machine starts, but this is not strictly the case, as the application of the heat necessary to freely evaporate the gas from the aqua ammonia carries over at the same time a considerable percentage of water, and as every particle of the water has a capacity for absorbing 700 times its bulk of gas, the efficiency of an absorption machine is greatly impaired. Absorption machines are more effective than air or gas machines, where there is no liquefaction, but are inferior to the best direct compression machines using volatile liquids of great latent heat, and of the latter class we consider the Wood-Bailie much in advance of all others.

When a substance passes from a solid to a liquid state, or from the latter condition to a gaseous one, a quantity of heat disappears, so far as thermometric effects are concerned, and is said to become latent. For instance, water which has just been produced by melting ice does not seemed to have gained any in temperature, but, nevertheless, it has absorbed 142 degrees of heat, which is known as the latent heat of water.

Extracts from the Report of a Board ordered by the Navy Department to examine the Ice Machine on the U. S. steamer "Fish Hawk":

A test of forty-eight hours was made, and during that time twenty-eight hundred and fifty-one (2851) pounds of ice was manufactured.

Indicator cards were taken, and it was found that it required about two horse-power to work this machine.

It was in continuous operation; and it is our opinion that any person with ordinary intelligence can be taught to take charge of it.

Among the advantages possessed by this machine are the following:

All the essential parts are mounted upon a rigid bed-plate. By this arrangement the working of the connecting pipes, and consequent leaking of joints and seams, are reduced to a minimum. Aboard ship such an arrangement is absolutely necessary to a successful working. *As the owners of the machine have a patent for this device, the machine is superior to all others in this respect.*

The working parts are so placed and arranged that each part is accessible for repairs and inspection; without much trouble and loss of time the different parts can be examined.

To overhaul any one part it is not necessary to remove another. The pump, wherein lies the chief merit of this machine, has its parts wholly encased. By an ingenious contrivance, in which the cylinder head is used also as the delivery valve, the pump can be made without "clearance."

By means of these devices the leakage of ammonia is reduced to a minimum, and the machine is made efficient.

It is not an intricate and complex machine, and its management can be entrusted to the machinists employed in the naval service.

So far as we have been able to ascertain, it is an economical machine. The absolute power required to work it is very little.

The chemical used and the efficiency of the apparatus make it possible to manufacture ice at a comparatively cheap cost.

Very respectfully,

Your obedient servants,

M. B. BUFORD, *Lt. Com'd'r, U. S. N.*

JOHN R. EDWARDS, *P. A. Eng., U. S. N.*

A. C. H. RUSSELL, *P. A. Surg., U. S. N.*

When a solid substance can be made to liquefy by a *weak* chemical attraction, cold results from sensible heat becoming latent. This is the principle of frigorific mixtures.

[*Copy.*] U. S. S. "TALLAPOOSA" (4th Rate),
NAVY YARD, NEW YORK, 17th June, 1884.

Hon. WM. E. CHANDLER, *Secretary of the Navy*,
Navy Department, Washington, D. C.:

SIR—It gives me much pleasure to report to the Department the satisfactory working of the "Wood-Bailie Ice Machine" placed on board of this ship some months ago.

For a time it gave trouble, owing to a defective second-hand engine, but now it is in excellent working order, and does all the work claimed by the inventors.

I earnestly recommend that it be adopted in the service, and placed on every sea-going ship.

Very respectfully,
J. F. MERRY, *Lt. Com'd'r, U. S. N., Com'a'g.*

[*Copy.*] STEAM YACHT "ATALANTA,"
CHARLESTON, S. C., January 18, 1884.

W. M. WOOD, Esq.,
Washington, D. C.:

DEAR SIR—We have had the ice machine at work for the last four days. The first lot made was 34 hours in the freezing, the second lot 22 hours, and the last 20 hours. The result of the trial seems to be that we can get from 900 to 1000 pounds a day by running the machine continuously for 24 hours.

The ice made was of very good quality, and on the whole I am much pleased with the working of the machine.

Yours very truly,
J. W. SHACKFORD.

Note.—Considerable more ice could have been produced in the same time if the moulds had been removed successively at short intervals. In each case above, the whole charge was put in at once, and in the first instance the entire apparatus had to be brought down to the freezing point.

Water contracts as its temperature is reduced until it reaches 39.1° Fahr., which is the point of maximum density; then it expands until it reaches 32° and congeals.

This is a striking exception to the general law, but the peculiarity consists in its anomalous expansion, and not that it expands in freezing.

Extracts from the Report of Passed Assistant Engineer N. P. Towne on the Ice Machine placed on the U. S. Steamer "Tallapoosa."

EDGARTOWN, MASS.,
Sept. 22, 1884.

The machine consists of a tank holding Anhydrous Ammonia, and a cylinder called a refrigerator, containing a coil of extra heavy iron pipe.

Through this coil the ammonia gas is expanded by its connection with the ammonia pump, which consists of two single acting cylinders, the piston being worked by a beam underneath the cylinders, and the whole inclosed in a tight casing. The peculiarity of this pump consists in the fact that the delivery valves are placed on the end of the cylinders, forming caps or heads, which are lifted by the pressure of the gas, and kept from seating until the piston starts on its return stroke.

The object of this arrangement is to prevent a large clearance space, which usually, in the case of gases pumped against a high pressure, reduces greatly the efficiency of the pump.

The cost of labor in the case of the apparatus being used on a man-of-war, must, in ordinary cases, be taken as nothing, as the small part of the Engineer's force required for its running could be detailed without much inconvenience. On the Tallapoosa the care of the machine was entrusted to two coal heavers, under the occasional supervision of the machinist of the watch. In the case of a ship where steam is kept all the time for purposes of distilling water, or for electric lighting, the amount of coal which would be consumed in the manufacture of ice would be inappreciable, and the cost practically nothing.

The only objection that I can see to having a machine on board of a ship is the space occupied, but in the case of this machine, very little is required, and in small ships, where space is restricted, a still smaller one might be used, and by a system of pipes leading through the water tanks in the hold, and through ice chests and scuttle butt, a complete refrigeration could be had, even without carrying the process so far as the formation of ice.

I would recommend strongly the adoption of this machine on government vessels, either of a size sufficient for ice making, or in a smaller size suitable for refrigeration alone.

Very respectfully,

N. P. TOWNE,
P. A. Eng'r, U. S. Navy.

Watery vapor is seldom absent from the atmosphere under natural conditions, the average amount present being about one per cent.

The capacity of water for absorbing heat is greater than that of any known substance.

The wine gallon (U. S. Standard) contains 231 cubic inches and weighs $8\frac{1}{3}$ pounds. The imperial gallon (English standard), contains 277.274 cubic inches and weighs 10 pounds.

At ordinary temperature and atmospheric pressure ammonia is only known in the gaseous state, for its boiling point is 28 degrees below zero, but at 60° Fahr. it becomes a liquid at a pressure of 6.9 atmospheres, about 100 pounds to the square inch.

Paraffine (mineral) oil is required for use in refrigerating machines where ammonia is employed, as animal or vegetable oils would combine with the ammonia and form soaps.

Air machines require five times the power expended by Wood-Bailie machines to produce a given result.

In making estimates for refrigerating machinery, it is necessary for us to know the amount of work required to be done, consequently the number of rooms to be cooled and their dimensions should always be clearly stated, as well as the following information, viz :

BREWERIES.

The method of insulation.
Number of barrels of wort to be cooled daily, or at each brewing.
Number of brewings per month.
Amount of ice previously used.

COLD STORAGE ROOMS.

Nature of goods stored, and the amount taken in and sent out daily.
The temperature required Fahrenheit.

PACKING HOUSES.

The amount of meat to be cooled daily.

OIL REFINERIES.

Number of barrels of oil to be cooled daily from a given temperature to the congealing point, ready for the press.

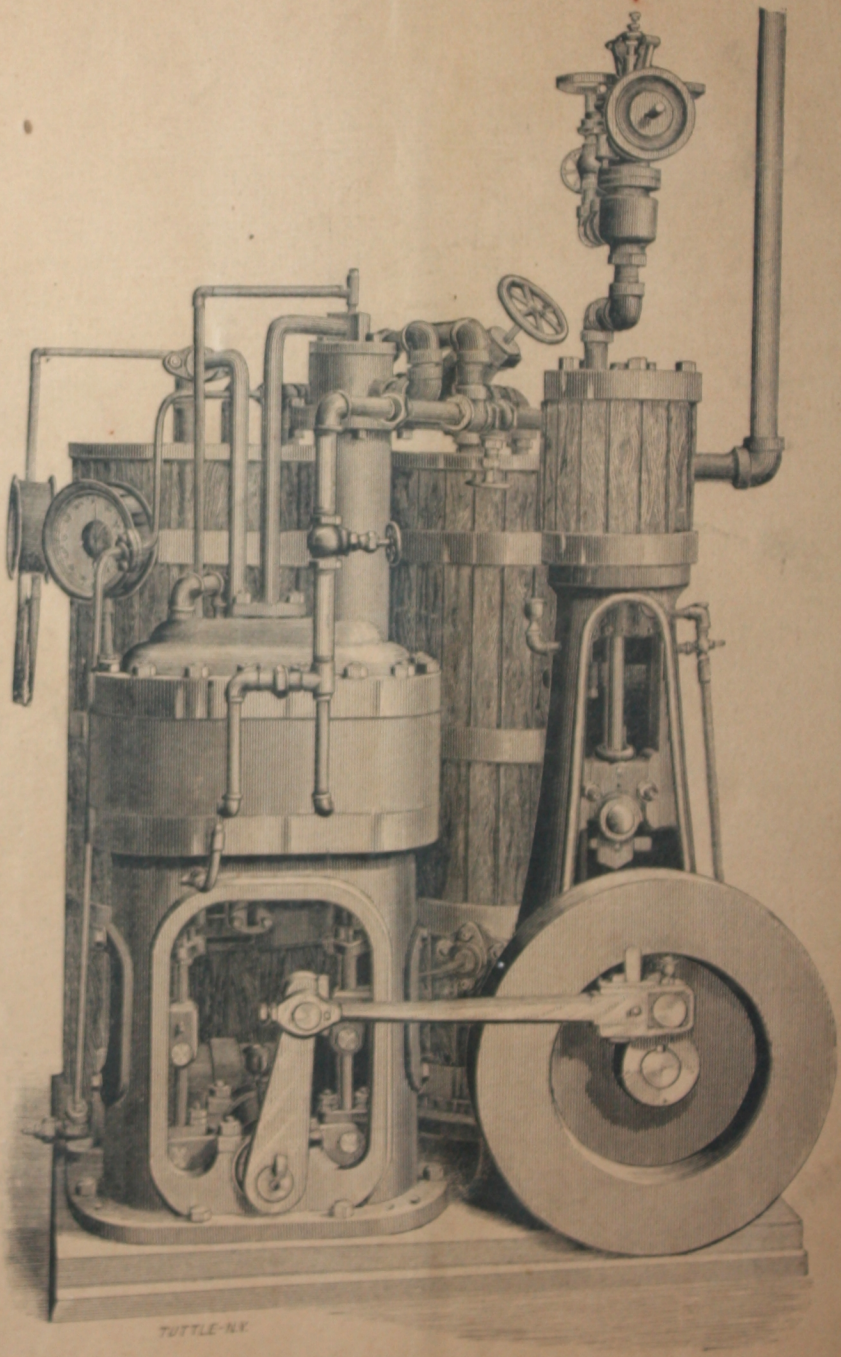
The kind of water available for condensing purposes and its temperature should always be stated.

Prices and detailed information will be given on application, also plans and estimates for refrigeration for special purposes. Address:

THE WOOD-BAILIE ICE MACHINE AND
REFRIGERATING COMPANY,

69 Wall St., New York.

MEMORANDA.



Wynkoop & Hallenbeck, Printers, 121 Fulton St., N. Y.